Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
Biennial Regulatory Review − Amendment of Parts 1, 22, 24, 27, and 90 to Streamline and Harmonize Various Rules Affecting Wireless Radio Services	)	WT Docket No. 03-264

COMMENTS OF TERRESTAR NETWORKS INC.

In a Further Notice of Proposed Rulemaking released on August 9, 2005,[1] the Commission sought comment on proposals to increase the radiated power permitted by the broadband PCS transmitting power rule.[2] TerreStar Networks Inc. ("TerreStar") urges the Commission to ensure that any power increase be accompanied by sufficient safeguards in the H-block to protect the viability of innovative Mobile Satellite Services ("MSS") with Ancillary Terrestrial Component ("ATC") in the adjacent 2 GHz band.[3]

TerreStar is working diligently to launch the next-generation MSS/ATC service in the 2 GHz MSS band, which will offer consumers as well as homeland security and public safety users ubiquitous access to an affordable, high-speed voice and data communications network. TerreStar's system will provide unprecedented benefits to private consumers and government

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[1] Report and Order and Further Notice of Proposed Rulemaking, *Biennial Regulatory Review − Amendment of Parts 1, 22, 24, 27, and 90 to Streamline and Harmonize Various Rules Affecting Wireless Radio Services*, FCC 05-144, WT Docket No. 03-264 (rel. Aug. 9, 2005) ("FNPRM").

[2] *See* 47 C.F.R. § 24.232.

[3] TerreStar is the prospective assignee of a 2 GHz MSS authorization and has contracted with Space Systems/Loral for a satellite that will operate in this band. TerreStar is actively working to launch a sophisticated 2 GHz MSS/ATC system that will deliver ubiquitous voice and high-speed packet data communications services.

and homeland security users alike, and it will, for the first time, bridge the digital divide between those living in heavily populated areas and residents of rural communities.

Unfortunately, as TerreStar informed the Commission in comments filed a year ago, PCS transmissions in the H-block could cause harmful interference to TerreStar's planned 2 GHz band ATC base stations, which will operate within a selected assignment in the 2000-2020 MHz band. Such interference would threaten the viability of this revolutionary new communications service.[4] To that end, TerreStar proposed last year that H-block base stations should be prohibited from transmitting in a guard band of at least 1 MHz, from 1999 to 2000 MHz.[5] In order to address the Commission's concern that "new entrants may not have adequate information about the types of technology being deployed in adjacent bands,"[6] TerreStar also agreed with the Commission's proposed requirement that "licensees in the [H-block] coordinate with nearby ATC licensees before commencing station operations."[7]

In the technical appendix to its comments, TerreStar demonstrated that even with the guard band, if H-block base stations were allowed to radiate as much as 32 dBW EIRP per sector[8] and were permitted out-of-band emissions of up to -90.2 dBW/MHz, 2 GHz band ATC

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[4] Comments of TerreStar Networks Inc., WT Docket Nos. 04-356 & 02-353 (filed Dec. 8, 2004) (attached at Appendix A) ("TerreStar Comments").

[5] *Id.* at 5-7.

[6] FNPRM at ¶ 60.

[7] Notice of Proposed Rulemaking, *Service Rules for Advanced Wireless Services in the 1915-1920 MHz, 1995-2000 MHz, 2020-2025 MHz and 2175-2180 MHz Bands*, WT Docket No. 04-356, FCC 04-218, at ¶ 95 (rel. Sep. 24, 2004); TerreStar Comments at 1-2, 7. *See also* FNPRM at ¶ 66 ("We . . . seek comment on possible methods to improve information sharing among licensees, including comment on the types of circumstances that would trigger information . . . sharing requirements.").

[8] As the Commission has noted, *see* FNPRM at n. 169, industry usage of the terms "per station" and "per carrier" can sometimes be unclear. In order to clarify its meaning and recognize that the relevant factor for interference purposes is the *total* amount of power radiated, not the

base station receivers would need to incorporate filters to reduce interference from the H-block to non-harmful levels.[9] The development of such filters would provide just enough protection to manage the interference and would impose costs on the nascent 2 GHz MSS/ATC providers. First, the filter cost would have to be borne for every affected 2 GHz band ATC base station.[10] Second, even with the use of the filter, the performance of at least the lower carrier of each 2 GHz band ATC base station would degraded by 10 dB or more, depleting capacity.[11] On balance, although H-block radiation at this level would markedly decrease the effectiveness of its ATC base stations, TerreStar believes that the "guard band + filter + coordination" solution to the H-block interference problem represents the best compromise between protecting 2 GHz band operations and ensuring efficient use of spectrum in the H-block.

It is elementary that increasing permitted power in one band necessarily intensifies harmful interference to users of an adjacent band. To this end, if the Commission decides to increase permitted power in the H-block, it should correspondingly increase the size of the guard band beyond the 1 MHz proposed by TerreStar last year. For instance, if permitted average EIRP were increased to the level proposed by CTIA,[12] the guard band would need to be increased further (at least doubled) to retain the same level of protection to 2 GHz band ATC

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amount radiated for each carrier, the Commission should adopt a rule which limits emissions on a *per sector*, not per carrier, basis.

[9] TerreStar Comments at 5-7 and Appendix to TerreStar Comments at v.

[10] *See* Declaration of Michael Reedy ("Reedy Declaration") (attached at Appendix B). TerreStar proposed that, because the H-block entrant would cause the interference, it should bear the cost of producing and installing these filters. TerreStar Comments at 5-6.

[11] Reedy Declaration at ¶ 6.

[12] *See* FNPRM at ¶ 51.

operations.[13] Such an increase would be too extreme, because it would deplete the availability of usable H-block spectrum.

More importantly, if the guard band is not correspondingly increased to match any increase in permitted radiation power, harmful H-block emissions will destroy the viability of any MSS/ATC service operating in the 2 GHz band. Such a result would be contrary to the Commission's longstanding goal of adopting spectrum policy which fosters cooperative, not destructive, use of radio frequencies by multiple licensees.[14] The Commission, therefore, is faced with a choice: it can increase permitted radiation power for PCS licensees in the H-block to the levels advocated by CTIA and reduce the usable size of that block from currently 4 MHz (assuming the 1 MHz guard band) to 3 MHz or less, or it can adopt only a 1 MHz guard band and permit H-block PCS licensees to radiate a maximum of 32 dBW EIRP per sector.

[13] *See* Reedy Declaration.

[14] The FCC recently adopted this goal as a part of its new Strategic Plan, which announces the Commission's intent to "develop policies that promote efficient and effective use of spectrum." That result will be realized, according to the Plan, by "accommodating shared use of spectrum by compatible users" and "minimizing harmful interference" between neighboring users. Federal Communications Commission, *Strategic Plan 2006-2011*, at 10, *available at* http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-261434A1.pdf (rel. Sep. 30, 2005).

To ensure that the full benefits of next-generation MSS/ATC services can be delivered to consumers and government users throughout the United States, TerreStar respectfully requests that the Commission adopt service rules for the H-block that will protect the technical integrity of the 2 GHz MSS/ATC from harmful PCS emissions.

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APPENDIX A

Before the
Federal Communications Commission
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In the Matter of	)	
	)	
Service Rules for Advanced Wireless Services in the 1915-1920 MHz, 1995-2000 MHz, 2020-2025 MHz and 2175-2180 MHz Bands	)))	WT Docket No. 04-356
	)	
Service Rules for Advanced Wireless Services in the 1.7 GHz and 2.1 GHz Bands	))	WT Docket No. 02-353

COMMENTS OF TERRESTAR NETWORKS INC.

Unless implemented with due safeguards, PCS operation in the H-block would pose a significant threat to the innovative Mobile Satellite Service (MSS) with Ancillary Terrestrial Component (ATC) plans of TerreStar Networks Inc. (TerreStar).[1] In developing service rules for the "H-block" PCS spectrum at 1995-2000 MHz, it is imperative that the Commission protect the integrity of the adjacent 2 GHz MSS/ATC licensees at this critical point of system development.

As documented in the attached engineering analysis, to mitigate the substantial interference that H-block transmissions could inflict upon TerreStar's ATC base stations, the Commission should adopt a minimum of 1 MHz guard band at 1999-2000 MHz and require H-block entrants to bear the cost of installing the filters necessary to protect ATC base stations from overload interference and harmful out-of-band emissions. TerreStar also asks that the Commission require H-block entrants to coordinate with the adjacent MSS/ATC licensee before

[1] TerreStar is the prospective assignee of a 2 GHz MSS authorization and has contracted with Space Systems/Loral for a satellite that will operate in this band. TerreStar is actively planning to launch a sophisticated 2 GHz MSS/ATC system that will deliver ubiquitous voice and high-speed packet data communications services.

commencing operations.[2] These modest proposals represent a reasonable compromise which would ensure new opportunities for innovation in the H-block without harming the public's interest in a viable 2 GHz MSS/ATC service.

I. THE COMMISSION SHOULD ENSURE THAT H-BLOCK OPERATIONS DO NOT JEOPARDIZE THE VIABILITY OF THE DEVELOPING 2 GHz MSS/ATC SYSTEMS.

As the Commission recognized in its *Notice of Proposed Rulemaking* (H-block Service Rules NPRM), without proper service rules PCS base stations operating in the H-block downlink spectrum could cause harmful interference to ATC base stations in the adjacent 2000-2020 MHz uplink spectrum.[3] The 2 GHz MSS licensees already face significant challenges in launching their systems; new operations in the H-block should not be allowed to exacerbate those challenges.[4] Most notably, the 2 GHz MSS licensees are working under strict milestone

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[2] Because coordination will be essential to successful adjacent PCS and MSS/ATC operations, the Commission should provide specific spectrum assignments to the 2 GHz MSS licensees. To date, it has provided only that "[e]ach 2 GHz MSS operator voluntarily will identify its selected spectrum at the time that the first satellite in its system reaches its intended orbit." *Establishment of Policies and Service Rules for the Mobile Satellite Service in the 2 GHz Band*, 15 FCC Rcd 16127, 16138 (2000) ("2 GHz MSS Service Rules R&O").

[3] Specifically, the Commission expressed concern "about the possibility of interference from base stations operating in the 1995-2000 MHz band to ATC base stations receiving in the 2000-2020 MHz band." *Service Rules for Advanced Wireless Services in the 1915-1920 MHz, 1995-2000 MHz, 2020-2025 MHz and 2175-2180 MHz Bands*, Notice of Proposed Rulemaking, WT Docket No. 04-356, FCC 04-218, (rel. Sept. 24, 2004) ("H-Block Service Rules NPRM"), at ¶¶ 94-95.

[4] In reallocating the spectrum that currently constitutes the H-block, the Commission stated that "new operations in the 1990-2000 MHz band will need to take into account these adjacent band operations when developing and deploying new services and equipment. Licensees and operators in this band should take measures both to ensure that their operations are protected from MSS/ATC operations and will protect MSS and ATC operations from interference." *Amendment of Part 2 of the Commission's Rules to Allocate Spectrum Below 3 GHz for Mobile and Fixed Services to Support the Introduction of New Advanced Wireless Services, including Third Generation Wireless Systems*, 18 FCC Rcd 2223, 2249 (2003) ("AWS Order").

conditions imposed by the Commission.[5] TerreStar takes these milestone requirements very seriously, and along with its partner, TMI Communications and Co., L.P., TerreStar recently certified to the Commission timely compliance with the requirement to complete Critical Design Review (CDR) of its 2 GHz MSS system. These design and construction plans, however, are premised on a world in which MSS/ATC uplink transmissions could operate without threat of harmful interference from adjacent H-block transmissions. Operations in the H-block should therefore only be allowed to the extent that they do not cause harmful interference to 2 GHz MSS/ATC systems and do not interfere with the ability of TerreStar or other 2 GHz MSS/ATC licensees to meet their milestone requirements.

Although the Commission in 2000 adopted a 2 GHz MSS band plan which provided for operation adjacent to the PCS "C5 Block" at 1985-1990 MHz, at that time the Commission had not authorized MSS licensees to provide a future Ancillary Terrestrial Component.[6] When the Commission did provide that option, in February 2003, it simultaneously reallocated the 1990-2000/2020-2025 MHZ and 2165-2180 MHz bands from MSS to Advanced Wireless Services (AWS) use.[7] While MSS providers strongly objected to the loss of spectrum, the one arguable "benefit" of the reallocation plan was that it provided separation between MSS/ATC and PCS operations. As the Commission considered specific allocations for the H-block, TerreStar therefore agreed with the wireless industry that the H-

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[5] TerreStar must begin physical construction of its satellite by March 2005, launch its satellite into its assigned orbital location by Nov. 2007, and certify that its entire MSS system is operational by November 2008. *See* 19 FCC Rcd 12603, ¶ 59 (2004).

[6] *See generally* 2 GHz MSS Service Rules R&O.

[7] AWS Order, 18 FCC Rcd at 2225.

block should be reserved as a guard band between PCS and MSS/ATC operations, allowing only lower-power uses that would not cause interference to adjacent services.[8]

Of course, the FCC's reallocation of nearly half of the MSS spectrum to AWS is itself another challenge confronting TerreStar; thus, it cannot afford to lose any of its remaining MSS/ATC spectrum as a result of PCS presence in the H-block.[9] MSS/ATC spectrum would be lost if the Commission allows PCS operations in the H-block to interfere with adjacent MSS/ATC systems, or if it alters the MSS/ATC service rules to accommodate the adjacent PCS operations. Indeed, TerreStar is already concerned that the current 4/4 MHz available to each 2 GHz MSS/ATC system is insufficient to create a truly robust service for the public.[10] Other licensees have identified the importance of an adequate spectrum allocation to the financial and technological viability of MSS/ATC systems.[11] It is clear that MSS/ATC licensees cannot afford to sacrifice any further spectrum as a result of PCS operation in the H-block. As described further below and in the attached engineering analysis, by adopting a minimum of 1 MHz guard band in the H-block <u>and</u> requiring the new H-block licensees to coordinate with and install

[8] *See, e.g.*, *Potential Expansion of PCS Band to Include H-Block*, CTIA - The Wireless Association™, Ex Parte Meeting, ET Docket No. 00-258 (July 29, 2004), at 14.

[9] *See* AWS Order, 18 FCC Rcd at 2225. The AWS Order reduced the total amount of 2 GHz MSS spectrum from 70 MHz to 40 MHz.

[10] Had the Commission maintained the original MSS band plan, TerreStar and the four remaining MSS providers would each be allocated 7/7 MHz of spectrum instead of the current 4/4 MHz. TerreStar believes that a robust 2 GHz MSS/ATC system requires at least 10/10 MHz of spectrum in order to provide both traditional voice services <u>and</u> high-speed packet data services. The current allocation of 4/4 MHz can barely provide for three CDMA2000 1X carriers.

[11] *See, e.g.*, Comments of New ICO Global Communications, ET Docket No. 00-258 (filed Oct. 22, 2001) ("[I]nvestors and financial institutions likely will be unwilling to provide capital for 2 GHz MSS systems unless those systems have access to sufficient spectrum capacity.").

suitable filters in adjacent ATC base station equipment, the Commission would preserve the technical integrity of the remaining 2 GHz MSS/ATC spectrum.

II. TO MITIGATE OVERLOAD POTENTIAL TO ATC BASE STATIONS, THE COMMISSION SHOULD ESTABLISH A MINIMUM OF 1 MHz GUARD BAND OVER THE H-BLOCK FREQUENCIES FROM 1999-2000 MHz AND REQUIRE H-BLOCK ENTRANTS TO INSTALL FILTERS ON MSS/ATC BASE STATIONS.

TerreStar agrees with the Commission's suggestion that "limiting the transmitter power" of H-block base stations is necessary to decrease the significant risk of overload interference to ATC base stations.[12] TerreStar believes that by adopting a minimum of 1 MHz of guard band at 1999-2000 MHz and requiring H-block licensees to provide ATC base stations with suitable front-end filters, the Commission can offer maximum flexibility to H-block licensees while protecting adjacent MSS/ATC operations. As demonstrated in the attached technical analysis, without these interference mitigation techniques, H-block emissions would cause unacceptably high levels of overload interference to the ATC receiver front ends of an MSS/ATC system.

Specifically, a minimum of 1 MHz guard band and requirement that H-block licensees install suitable filters on adjacent ATC base stations would allow the ATC receiver to develop approximately 40 dB of discrimination necessary to safeguard against harmful overload interference. It also would ensure that emissions from H-block operations would not increase the noise floor of the adjacent MSS provider beyond the industry-accepted coordination trigger of six percent noise increase ($\Delta T/T$).

[12] H-Block Service Rules NPRM at ¶ 95.

In proposing these service rules, TerreStar emphasizes that it has sought to provide maximum possible flexibility to new entrants. For example, TerreStar considered requesting a 2 MHz guard band in the H-block, but rejected that approach out of awareness that a guard band of that size would be a less efficient use of spectrum. TerreStar instead advances the 1 MHz minimum guard band + filter + coordination solution, even though that approach is technically challenging for TerreStar and produces a coordination burden, representing additional risk for MSS/ATC licensees. Recognizing the Commission's desire to foster a robust H-block service, TerreStar also recommends that across the frequency range from 1995-1999 MHz, base stations be allowed to transmit up to an aggregate Effective Isotropic Radiated Power (EIRP) per sector of 32 dBW.

In addition to the technical realities documented in the attached engineering analysis, TerreStar's modest interference mitigation proposal is supported by ample Commission precedent. For example, the Commission's Part 73 rules significantly restrict operational changes by noncommercial educational (NCE) FM broadcast stations if such changes would increase predicted interference to a viewer of spectrally adjacent television channel 6, unless the NCE station installs a filter at affected viewers' television receivers.[13] And earlier this year, the Commission established a 1 MHz guard band at 2495-2496 MHz to protect adjacent CDMA MSS systems from emissions produced by broadband radio service (BRS) licensees in the 2496-

[13] *See* 47 CFR § 73.525(b)(2)(i). Under this rule, changes in NCE facilities which increase interference to viewers of channel 6 may not be made unless there is a 2:1 ratio of the population for which the change will reduce interference to the population for which the change will increase interference. However, the calculation of negatively affected persons may be adjusted downward by one person for every two filters which the NCE station "effectively installs" on television receivers within the predicted interference area. *Id.*

2500 MHz spectrum.[14] Guard bands and filtering requirements are proven and balanced methods of reducing harmful interference to adjacent licenseholders from a new entrant's operations, and the Commission should apply these well-tested practices to its H-block service rules.

III. THE COMMISSION SHOULD ALSO REQUIRE H-BLOCK LICENSEES TO COORDINATE WITH ADJACENT MSS/ATC LICENSEES BEFORE COMMENCING OPERATIONS.

The Commission's proposed requirement that "licensees in the [H-block] coordinate with nearby ATC licensees before commencing station operations" would also go a long way in preventing harmful interference to the adjacent MSS/ATC licensee.[15] Such coordination will assist H-block operators in meeting their obligation to install suitable filters on ATC base station equipment and prevent other potential interference problems.

Exemplifying the need for coordination, PCS base station transmissions in the H-block may create harmful interference, particularly when S-band ATC base station receivers are "co-located" with H-block base station transmitters (*i.e.*, when the adjacent operations share a common base station tower). In that situation, ATC base stations cannot tolerate more than an Out-of-Band Emissions (OOBE) EIRP density limit of -150 dBW/Hz (-90 dBW/MHz) per base station sector of the H-block. Because ATC and PCS base stations will not always be collocated, a coordination requirement would allow parties the opportunity to mutually agree to a less stringent OOBE standard and thereby provide reasonable flexibility to H-block licensees.

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[14] *Review of the Spectrum Sharing Plan Among Non-Geostationary Satellite Orbit Mobile Satellite Service Systems in the 1.6/2.4 GHz Bands, Amendment of Part 2 of the Commission's Rules*, 19 FCC Rcd 13356, ¶ 74 (2004).

[15] H-block Service Rules NPRM at ¶ 95.

IV. TERRESTAR AGREES WITH THE COMMISSION THAT THE MSS/ATC SERVICE RULES SHOULD NOT BE AMENDED.

In light of the challenges facing 2 GHz MSS licensees, TerreStar commends the Commission for its decision to not "modify the OOBE limits required of MSS/ATC mobiles to protect operations below 2000 MHz."[16] As explained above, with an already limited amount of spectrum available for MSS/ATC operations, TerreStar and other 2 GHz MSS licensees cannot afford to see any of their remaining spectrum encumbered as a result of PCS operations in the H-block. Nor should MSS/ATC licensees be required to bear the cost of installing new equipment (*i.e.*, filters) necessary to prevent harmful interference to their ATC base stations. And MSS/ATC licensees already face stringent OOBE limits.[17] Accordingly, TerreStar asks that the Commission place the burden of protecting both adjacent licensees and their own operations on the provider or providers which voluntarily elect to operate within the H-block spectrum, consistent with the Commission's decisions in last year's AWS Order and the recent H-block Service Rules NPRM.

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[16] *Id.* at ¶ 97.

[17] 47 U.S.C. § 25.252.

CONCLUSION

The Commission should adopt service rules for the H-block that protect the technical integrity of the 2 GHz Mobile Satellite Service with ATC, which is at a crucial stage in its development. MSS/ATC carriers already face significant challenges, including strict milestone requirements and a limited quantity of spectrum in which to deploy MSS/ATC services. By providing at least a modest 1 MHz guard band at 1999-2000 MHz and requiring the H-block entrants to coordinate with and provide filters to ATC base stations, the Commission can foster both new uses for the H-block and the development of an innovative MSS/ATC service in the 2 GHz band.

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APPENDIX

Engineering Analysis

H-Block Interference Potential to S-Band MSS/ATC Operations

Interference Potential to S-Band Operations from H-Block Transmissions

1. Overload Interference and Out-of-Band Emissions (OOBE) Interference to S-Band ATC Base Stations from H-Block Base Stations for Facilities that are Collocated on the Same Tower

H-block base station transmitters using the frequencies from 1995 MHz to 2000 MHz may be collocated (on the same tower) with S-band ATC base stations receivers receiving over the frequency range from 2000 MHz to 2020 MHz. In what follows, we estimate the potential interference levels from an H-Block base station transmitter into a co-located S-band ATC base station receiver, and identify necessary steps to reduce the interference to acceptable levels. Two interference mechanisms are examined: 1) ATC receiver overload and 2) ATC receiver noise increase due to the Out-of-Band Emissions (OOBE) of the H-block transmitter. For this analysis, an aggregate allowance of 6% increase to the ATC receiver noise floor ($\Delta T/T = 6\%$) is apportioned equally between overload inter-modulation and OOBE components. Each of these interference components is examined in detail below:

I. ATC Receiver Overload and Inter-Modulation (IM) Product Generation:

The presence of large H-Block signals at the input to an S-band ATC base station receiver may cause the front-end low noise amplifier (LNA) of the S-band ATC base station receiver to overload (operate in the non-linear region of its amplitude response), generating IM products, some of which may fall within the ATC receive band. An analytical model of the LNA non-linearity has been developed to estimate the maximum tolerable LNA input levels that will maintain IM interference in the ATC receiver to within the 3% $\Delta T/T$ limit. This model is described below:

Analytical Model of LNA Non-Linearity: The input/output characteristic of the front-end LNA is modeled by the following third-order expression:

$$y(t) = \alpha_1 x(t) + \alpha_3 x^3(t) \qquad (1)$$

where $x(t)$ is the input voltage, $y(t)$ is the output voltage, and α_1 and α_3 are constant coefficients determined from the LNA performance specifications. The value of α_1 is simply the small signal voltage gain of the LNA measured in the linear part of its response curve. If we normalize the response to unity-gain ($\alpha_1 = 1$), then it can be shown that α_3 is related to the 1-dB compression point input power P_{1dB} as follows:

$$\alpha_3 = -0.0725/P_{1dB} \qquad (2)$$

where P_{1dB} in (2) is expressed in linear units. The negative sign in (2) comes from the fact that the LNA non-linearity is compressive, so the value of α_3 must be negative.

The 1-dB compression point input power can be determined from the input third-order intercept point (IIP3), which is commonly used to specify amplifier linearity, using the following relation:

$$P_{1dB}\ (\text{dBm}) = \text{IIP3 (dBm)} - 9.6\ \text{dB}. \quad (3)$$

Now let the input signal $x(t)$ in (1) comprise 3 equal-amplitude carriers:

$$x(t) = A\left[\cos(\omega_a t) + \cos(\omega_b t) + \cos(\omega_c t)\right] \quad (4)$$

where ω_a, ω_b, and ω_c all reside within the H-Block frequency band. By substituting (4) into (1) and solving for the various cross-product terms, the relevant IM product powers (referenced to the LNA input) are determined to be:

a) 2A-B type IM product:

$$P_{2A\text{-}B} = 2.25 P_{cxr}^{3} \alpha_3^{2} \quad (5)$$

b) A+B-C type IM product:

$$P_{A+B\text{-}C} = 9 P_{cxr}^{3} \alpha_3^{2} \quad (6)$$

where P_{cxr} is the input power of each carrier in (4), that is, $P_{cxr} = A^2/2$.

For this 3-carrier example, one "A+B-C" type and up to three "2A-B" type IM products can fall into the adjacent ATC receive band. Let P_{IM} denote the total IM power, referenced to the LNA input, falling into the ATC receive band. Then:

$$P_{IM} = P_{A+B\text{-}C} + 3\,P_{2A\text{-}B} = 15.75\,P_{cxr}^{3} \alpha_3^{2} \quad (7)$$

Now let P_{Limit} be the maximum IM power, referenced to the LNA input, that causes 3% $\Delta T/T$ noise increase to the S-band ATC receiver. Equating P_{IM} to P_{Limit} in (7) and rearranging terms, we can solve for the corresponding maximum allowable input power to the LNA from the H-Block carriers, denoted P_H, as follows:

$$P_H = 3\left[P_{Limit}/(15.75\alpha_3^{2})\right]^{1/3} \quad (8)$$

Table 1 below provides a detailed calculation of the amount of filter rejection required to maintain the IM power to within the 3% $\Delta T/T$ limit.

Table 1 - Calculation of Front-End Filter Rejection of an S-Band ATC Base Station to Prevent LNA Overload from H-Block Base Station Transmissions

PARAMETER	VALUE	UNITS	Notes
ATC receiver Noise Figure:	5	dB	
Thermal noise density referenced to LNA input	-168.98	dBm/Hz	
Self-interference factor:	3	dB	
ATC receiver input noise in 1.25 MHz:	-105.01	dBm/1.25MHz	
3% $\Delta T/T$ allowance for IM products:	-120.24	dBm/1.25MHz	P_{Limit}
ATC base station LNA input IP3:	15	dBm	Per manufacturer's specifications
LNA 1-dB compression point:	5.4	dBm	Equation (3)
Small signal voltage gain $\alpha 1$:	1		Normalized to 1
Third-order term coefficient $\alpha 3$:	-20.91		Equation (2)
Max. aggregate LNA input power for 3 carriers	**-28.10**	dBm	P_H, Equation (8)
H-block base station EIRP per sector:	32	dBW	
H-block base station antenna isolation toward S-band ATC antenna:	-17.5	dB	
Additional interference from other sectors:	1	dB	
Additional interference from reflected paths:	1	dB	
Free Space Loss (2m antenna separation)	44	dB	
ATC antenna gain toward H-block antenna	0	dBi	
ATC base station cable/connector losses:	1.5	dB	
Received H-block power at S-band ATC front-end (LNA) input:	1.0	dBm	
Required Rejection by S-band ATC Front-End Filter:	**29.1**	**dB**	

Given the fairly simplistic non-linear model used in the above analysis (5th-order and higher IM products are ignored), the actual filter rejection may need to exceed the 29.1 dB value calculated above.

Considerations of 3GPP2 Document C.S0010B: In addition to the need for front-end filtering to reduce IM generation as described above, 3GPP2 Document C.S0010B, "Recommended Minimum Performance Standards For cdma2000 Spread Spectrum Base Stations", provides minimum standards for single tone overload at interfering carrier input levels of +87 dB and +80 dB above the desired CDMA carrier, corresponding to frequency offsets of 900 kHz and 1.25 MHz (separation between center frequencies), respectively. The desired carrier's input power is not specified in the standard. (The base station is allowed to control the MT's transmit power using normal power control methods). If we assume a "target" C/N at the receiver input of -13 dB, then absent of any self-interference, the desired CDMA carrier level at the receiver input could be as low as -121 dBm. Therefore, we conclude that the ATC base station receiver should conservatively accommodate aggregate input signal power from the H-Block of up to -41 dBm (-121dBm + 80 dB) without suffering unacceptable degradation. From Table 1, the received H-Block carrier power at the ATC receiver input (absent of front-end filtering) was estimated to be +1 dBm. Therefore, to maintain an input level below -41 dBm, the front-end filter rejection of the H-Block frequencies would need to be about 42 dB.

Filter Guard Band Requirement: Front-end filter designs that meet the above attenuation requirements may be realizable provided that sufficient guard band is allocated to accommodate the transition region between pass-band and stop-band performance.[1] **A minimum guard band of 1 MHz should be allocated in the upper portion of the H-Block (1999-2000 MHz) to allow implementation of a filter.**

II. **Out-of-Band Emissions (OOBE) interference from H-Block Base Stations into S-Band ATC Base Station Receivers:** In Table 2, we estimate the maximum H-block base station OOBE EIRP density per sector to maintain the noise increase at an S-band ATC base station receiver to within the 3% ΔT/T limit:

Table 2 - Calculation of Aggregate per Sector H-Block Base Station Out-of-Band Emissions (OOBE) EIRP Density to Limit Impact to S-Band ATC to 3% ΔT/T

PARAMETER	VALUE	UNITS
ATC receiver Noise Figure:	5	dB
Thermal noise density N0 referenced to LNA input	-198.98	dBW/Hz
Self-interference factor:	3	dB
ATC receiver input noise in 1 MHz:	-138.98	dBW/MHz
3% ΔT/T allowance for OOBE:	-151.2	dBW/MHz
H-block antenna isolation toward ATC antenna:	-17.5	dB
Factor for multiple H-block sectors:	1	dB
Factor for reflected path interference:	1	dB
Free Space Loss (2m antenna separation)	-44	dB
ATC antenna gain toward H-block antenna	0	dBi
ATC BTS cable/connector losses:	-1.5	dB
Total coupling loss from H-block Tx antenna to ATC receiver	-61	dB
H-block base station sector OOBE EIRP density:	**-90.2**	**dBW/MHz**

It is seen from Table 2 above that the OOBE EIRP density limit of -90.2 dBW/MHz (or equivalently -150.2 dBW/Hz) is necessary to protect S-band ATC receivers.

[1] TerreStar is currently working with major infrastructure vendors to evaluate the technical feasibility of such a filter and the cost impact to its S-band ATC network.

2. Overload Interference and Out-of-Band Emissions (OOBE) Interference to S-Band ATC Base Stations from H-Block Base Stations for Facilities that are not Collocated on the Same Tower

For H-block and S-band ATC base station facilities that are not collocated on the same tower, we have evaluated the filter rejection requirement necessary for the S-band ATC base station receiver, to prevent harmful overload interference, as a function of separation distance from the nearest H-block base station transmitter. Figures 1 and 2 below present the results for three propagation models: (i) Walfisch-Ikegami non-Line-of-Sight (W-I NLOS), (ii) Walfisch-Ikegami Line-of-Sight (W-I LOS), and (iii) free-space propagation. Figure 3 presents results for OOBE EIRP density limits subject to the same propagation channels.

The most appropriate propagation model for predicting/estimating the potential for interference will depend on (and will have to be chosen in accordance with) the separation distance between an H-block base station tower and an S-band ATC base station tower; also, the local environmental morphology is a determining factor. For base stations located in dense-urban and urban areas and for a separation distance of about 40 meters or more, the filter rejection requirement to prevent harmful interference to the ATC receiver will likely be dictated by the bounds corresponding to the W-I LOS and W-I NLOS curves. For a separation distance of less than 40 meters, the filter rejection requirement to prevent harmful interference to the ATC receiver will typically be dictated by the bounds corresponding to the W-I LOS and free-space propagation curves. For suburban environments, a similar "rule of thumb" holds but instead of having a transition phase between one propagation model and another at about a 40 meter separation, the transition phase typically occurs at about 100 meters.[2]

Figures 1 through 3 below assume perfect boresight alignment between a transmitting H-block base station sector antenna and a receiving S-band ATC base station sector antenna. It can be seen from Figures 1 and 2 that for suburban environments, where propagation for small distances (typically up to 100 m) is governed by the bounds between free-space and W-I LOS model, the filter requirements previously stated (for the co-located case) hold, specifically for separation distances of less than or equal to about 60 m, and may even need to become stricter. The same conclusion may be reached for the previously stated OOBE EIRP density limit (of the co-located case) as can be observed from Figure 3. For separation distances greater than 60 m and/or for urban environments, the filter requirements and/or the OOBE EIRP density limit may be relaxed subject to careful coordination and further studies by the parties (H-block and S-band ATC operators).

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[2] Depending on local environmental morphology profiles, the transition distances may be smaller or larger.

Figure 1 – S-Band ATC Base Station Front-End Filter Rejection Requirement (dB) to Prevent Harmful Overload/IM Interference

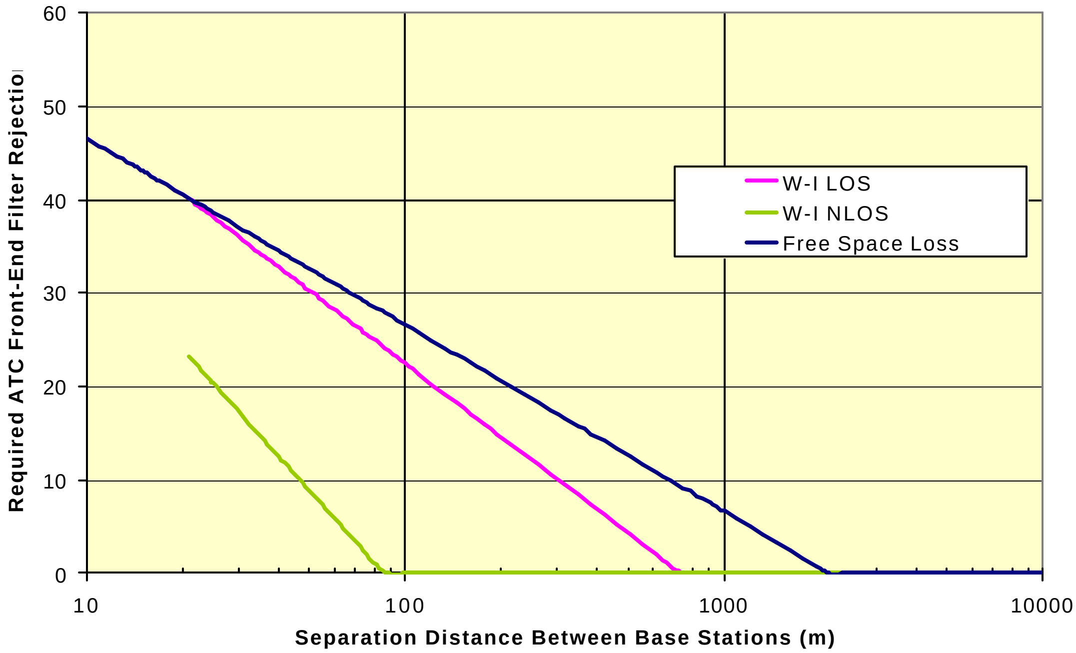


Figure 2 – S-Band ATC Base Station Front-End Filter Rejection Requirement to Prevent Harmful Overload Interference (In Accordance with 3GPP2 Standard/Specification)

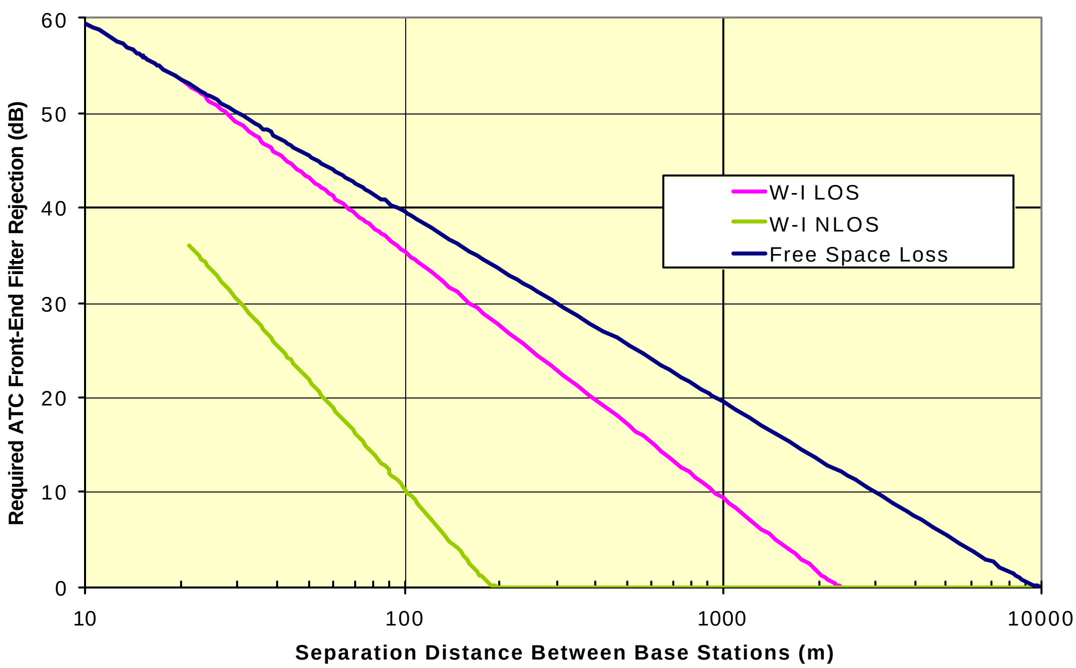
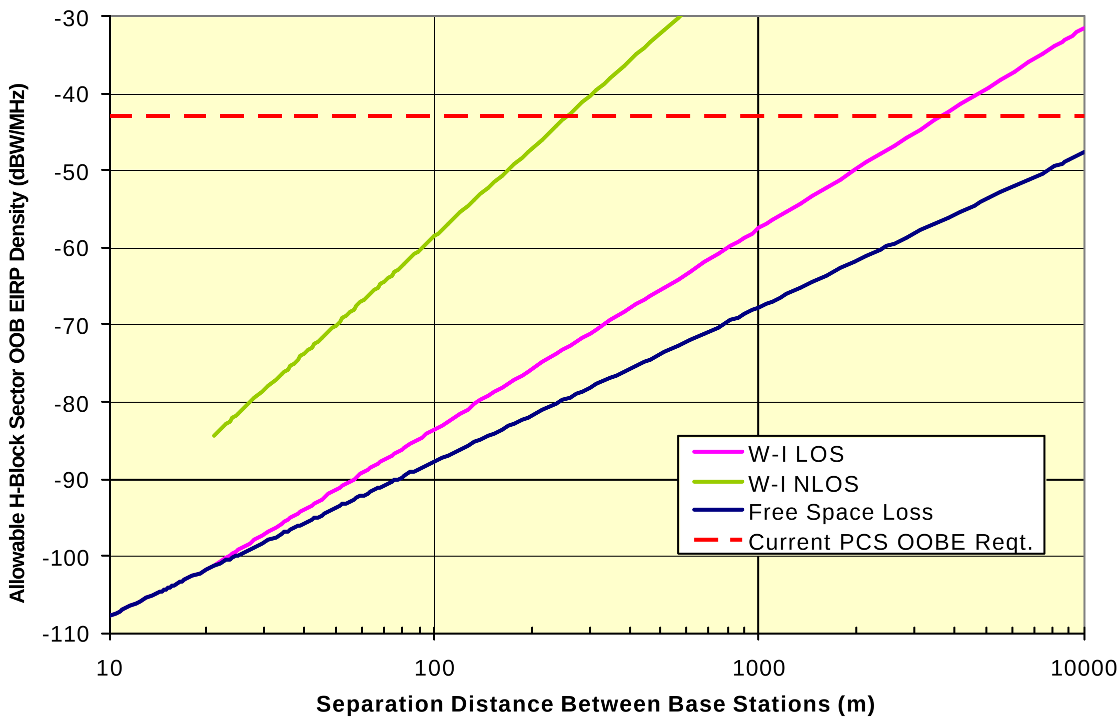


Figure 3 – H-block Out-of-Band Emissions (OOBE) EIRP Density per Sector to Prevent Harmful Interference to S-Band ATC Base Station Receivers



APPENDIX B

DECLARATION OF MICHAEL REEDY

I, Michael Reedy, hereby state the following:

1. I am Senior Vice President of Operations for TerreStar Networks Inc. ("TerreStar").

2. TerreStar has analyzed the feasibility of constructing a filter to limit harmful interference to its Ancillary Terrestrial Component ("ATC") base stations operating in the S-band, caused by PCS licensees operating in the neighboring H-block.

3. To conduct this analysis, TerreStar assumed that H-block licensees would be limited to an effective isotropic radiated power ("EIRP") of no more than 32 dBW per sector and out-of-band emissions ("OOBE") of no greater than -90.2 dBW/MHz, and that the FCC would institute a guard band of 1 MHz (from 1999 to 2000 MHz) between occupied frequencies in the H-block and occupied frequencies in the S-band.

4. We have concluded that a 6 pole ceramic notch filter could be constructed to suppress H-block transmitter power by 42 dB and avoid harmful interference to TerreStar's planned S-band ATC base stations. Such a filter would be approximately 2.5" width x 12.5" length x 2.25" height, with connectors on opposite 2.5-inch faces. In response to TerreStar's inquiry, a radio filter manufacturing vendor estimated that it would take between 14 and 16 weeks to manufacture these filters in volume.

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5. Developing and constructing these filters, however, would be non-trivial. Although such a filter would be expensive and difficult to develop, it is not possible to estimate the exact cost without conducting in-depth experiments.

6. In addition, at 2000 MHz, the insertion loss to the S-band ATC base station is likely to be greater than 10 dB, even with the use of a filter. An insertion loss at this level would cause a significant decline in the capability of the ATC base station.

7. If maximum EIRP levels were raised above the 32 dBW per sector used for these calculations, it would almost certainly be impossible to construct a filter which would suppress the transmitter power of a PCS station operating at 1999 MHz by 42 dB. In order to create an effective filter under these circumstances, a larger guard band would have to be imposed. Specifically, if PCS stations in the H-block were permitted maximum EIRP of as much as 3280 Watts per carrier in non-rural areas or 6560 Watts per carrier in rural areas, an H-block guard band of at least 3 MHz would be required to satisfactorily limit harmful emissions.

I declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge and belief.

Michael Reedy

December 19, 2005